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PROGRESS IN MAKING FREE-AIR PRESSURE AND WIND CHARTS.[1]

By C. LeRoy Meisinger.

[Weather Bureau, Washington, D. C., Apr. 20, 1921.]

SYNOPSIS.

This study, which has been outlined in earlier papers, has been carried forward so that it now includes the results from all kite flights made at about 8 a. m., at all the aerological stations of the Weather Bureau, up to the end of 1920. Smoothed tables of differences between the mean temperature of the air column and the surface temperature, under different conditions of surface wind, have been constructed for each month from isopleths which were drawn from the original data. These smoothed tables have been modified to include the effect of vapor pressure. With such tables it is possible to draw free-air maps of the eastern United States for each month according to the surface wind direction, and, from the maps, to interpolate for any other station. A comparison of observed and computed pressures at the 1 and 2 kilometer elevations above sea-level in 20 kite flights selected at random after January 1, 1921, indicates that the method will probably be of sufficient accuracy to be useful.

In previous papers[2] a method has been outlined by means of which it is proposed to reduce barometric pressure to levels in the free air. The central idea of the method is that surface wind directions are an index to temperatures aloft. Such temperatures must be known in order to substitute correct numerical values in the hypsometric formula for the term representing the mean temperature of the air column. The plan of the investigation has been, therefore, to classify for each month, according to surface wind direction, the differences between surface temperature and the mean temperatures of the air columns between the surface and the 1- and 2-kilometer elevations above sea level. These differences have been determined from all the kite flights made at about 8 a. m. at the Weather Bureau aerological stations up to the end of 1920, comprising about 4,000 observations to the 1-kilometer level, and above 3,000 observations to the 2-kilometer level. For each of the seven aerological stations, isopleths, or diagrams in which months are plotted as abscissae and wind directions as ordinates and which show lines of equal temperature difference were constructed; and from them in turn tables of smoothed temperature differences were made. Examples of such isopleths were given in the Review for May, 1920 (p. 257), although those there presented have since been modified by the inclusion of more data.

Of the variables in the hypsometric formula, that representing vapor pressure is second only to the variable representing the mean temperature of the air column in its effect upon the reduced pressure. Consequently, in order to include adequately the effect of this term, small values of temperature, which were equivalent to the corresponding effect of vapor pressure, were added to each of the values in the tables obtained from the isopleths. The values of vapor pressure were obtained from the summary of aerological data now in preparation in the Aerological Division of the Weather Bureau, and are the mean monthly values. Thus, from tables showing the differences of temperature between the 1- and 2-kilometer levels and the surface and including the effect of vapor pressure, values were plotted on maps of the eastern United States and lines of equal difference drawn. Figure 1 shows such maps, the first being for south winds at all stations on July 1; the second for south winds at all stations on December 1; the third and fourth for north winds on the corresponding dates. The effect of coastal and continental conditions is evidenced by the smooth progression from a temperature inversion, even in summer, in the interior to a decrease of temperature with height along the eastern coast, even in winter, with all surface wind directions. These results are exactly what one might expect, and the very easy transition from one map to the next, when many are arranged in order, together with the smoothness with which the values distribute themselves, indicates that the probable accuracy is satisfactory. This was also indicated by a statistical study of the errors in an earlier paper. From these maps it will be possible to construct reduction tables for most of the eastern United States, and, after considerable laborious tabulation, to draw daily upper-air maps.

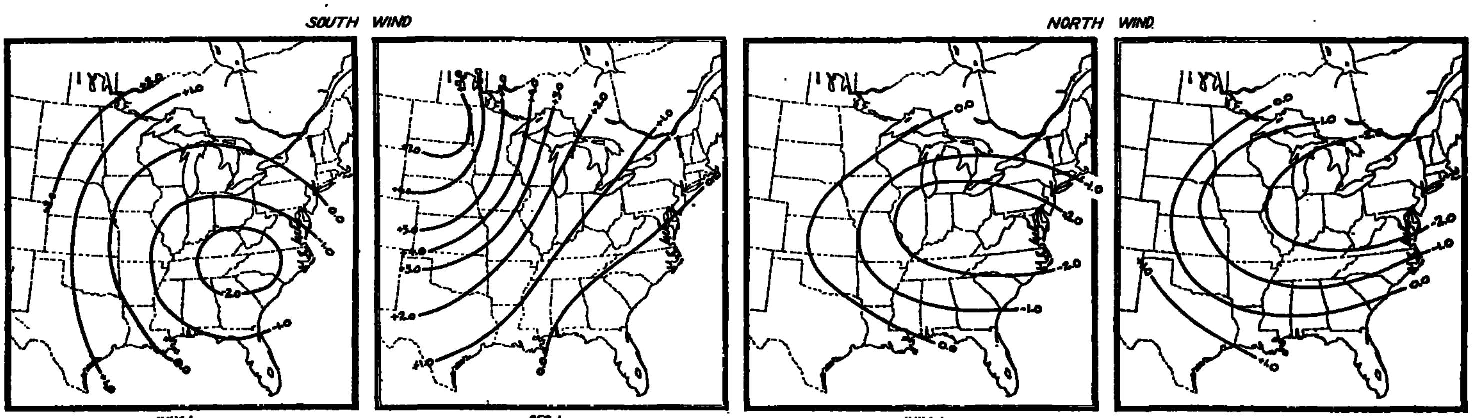

Fig. 1.—Maps of eastern United States showing the difference between the surface temperature and the mean temperature of the air column (including the effect of vapor pressure) to the 1 km. level above sea level, with north and south winds on July 1 and Dec. 1, in degrees, centigrade.

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[1] Presented before the American Meteorological Society, at Washington, D. C., Apr. 20, 1921.

[2] Cf. *Bulletin of the American Meteorological Society*, Jan., 1920, p. 8; May, 1920, p. 53; also Mo. Weather Rev., May, 1920, pp. 251-263. The essential features of the method were also mentioned in *Science*, Oct. 29, 1920, pp. 411, 412.

TABLE 1.—*Comparison of observed and computed pressures at upper levels.*

Station.	Date.	Surface.		Pressure aloft.					
				1-km. level.			2-km. level.		
		Wind dir.	Pressure.	Obsd.	Cmptd.	Diff.	Obsd.	Cmptd.	Diff.
	1921.		*mb.*	*mb.*	*mb.*	*mb.*	*mb.*	*mb.*	*mb.*
Groesbeck, Tex.	Jan. 13	NW	1,000.7	898.9	899.0	0.1	794.1	792.7	−1.4
	Jan. 21	SE	1,007.7	910.4	911.3	0.9	808.3	810.1	1.8
	Feb. 10	NW	998.9	899.6	899.5	−0.1	795.4	795.1	−0.3
	Feb. 18	E	1,005.2	905.1	904.6	−0.5	800.9	800.1	−0.8
Broken Arrow, Okla.	Jan. 1	W	985.3	896.5	896.2	−0.3	792.5	791.9	−0.6
	Jan. 27	S	999.9	907.7	908.9	1.2	803.9	801.2	−2.7
	Feb. 10	NW	985.4	896.0	895.7	−0.3	791.7	791.9	0.2
	Feb. 21	S	989.8	899.1	898.9	−0.2	793.1	792.1	−1.0
Ellendale, N. Dak.	Jan. 8	W	970.6	901.8	902.8	1.0	792.1	794.1	2.0
	Jan. 24	NE	978.0	909.6	909.7	0.1	800.5	799.4	−1.1
	Feb. 8	SW	956.5	891.0	890.0	−1.0	784.9	780.2	−4.7
	Feb. 27	SW	956.5	893.0	891.4	−1.6	789.6	786.4	−3.2
Drexel, Nebr.	Jan. 2	SW	962.1	892.2	891.9	−0.3	787.4	787.2	−0.2
	Jan. 7	N	968.9	898.4	898.4	0.0	792.1	793.7	1.6
	Feb. 7	N	977.3	904.1	902.7	−1.4	794.2	792.3	−1.9
	Feb. 14	E	973.3	904.4	903.1	−1.3	802.1	802.1	0.0
Royal Center, Ind.	Jan. 5	NW	990.6	898.0	898.7	0.7	792.0	792.5	0.5
	Jan. 6	SE	998.3	906.6	906.5	−0.1	802.3	800.8	1.5
	Feb. 2	SW	991.7	899.3	899.5	0.2	790.0	792.1	2.1
	Feb. 14	NE	994.2	904.1	903.5	−0.6	800.2	799.1	−1.1
Mean difference						0.5			1.4

As a test of the method, 20 comparisons were made for each of the two levels at each of the active kite stations (see Table 1), and it was found that, for the 1-kilometer level, the differences between computed and observed [3] values were 1 mb. or less in 16 cases, the remaining 4 not exceeding 1.6 mb. For the 2-kilometer level, where, of course, larger discrepancies were to be expected as a result of the long reduction column, 8 cases gave differences of 1 mb. or less; 16 were below 2 mb.; 18 were below 3 mb.; and the remaining 2 were 3.2 and 4.7 mb., respectively. The mean difference was 0.5 mb. for the 1-kilometer level and 1.4 mb. for the 2-kilometer level. A further careful discussion of the results and some trial upper-air maps will be made. The work seems to hold promise of being of considerable value to aviation, and it is hoped will be of subsequent value in attacking the problem of Plateau barometry.

METEOROLOGY IN THE SERVICE OF AVIATION.

By G. DOBSON.

[Abstracted from *Aeronautics*, Feb. 17, 1921, pp. 113–116; published in greater detail in *The Aeronautical Journal*, May, 1921, pp. 223–236.]

The well-known problems confronting the aeronautical meteorologist are discussed with special reference to England. The information most needed is, first, with respect to the variation of speed and direction of wind with height; second, the heights of cloud bases and the thickness of the layers; third, warnings in case clouds come so near the surface as to make landings dangerous; and, fourth, the nature of the weather likely to be encountered along the route, with special attention to squalls or other local disturbances. After discussing the various means of obtaining these data, the author inclines to the belief that the best results will come from locating meteorological stations along the routes, and having these stations report their weather and upper-air data obtained from frequent kite-balloon ascensions, assuming the conditions between observations to remain the same as at observation. He admits, of course, the value of widespread aerological stations, but rules them out for financial reasons. The danger of having kite-balloon cables in the air near flying routes is disposed of by having the meteorological stations as much as 30 to 50 miles either side of the route. Communication from these stations should be by wireless.

The methods of dispersing fog over small areas, namely, heating, blowing powdered calcium chloride into the air, and electrical discharge, are discussed and negative conclusions drawn. Heating the air with coal heaters would not yield sufficient heat and would add nuclei of condensation to the air. Spraying powdered calcium chloride into the air would tend to collect the water out of the air about the particles until they would be so heavy as to fall. This would require great quantities of the powder, but would give the greatest promise of any of the methods. The method of dispersing fog in the laboratory by means of the brush discharge would have an inconsiderable effect in the open air. Moreover, if any method for dispersing or precipitating fog were practicable, the quantity of water which would result would be considerable.

The author concludes his paper by the expression of mild pessimism regarding the ability of the meteorologist at present to give the aviator just what he wants, although the importance of meteorology in aviation is denied by none.

The paper was discussed by Col. Gold, Maj. Gen. W. S. Brancker, Col. W. D. Beatty, and Maj. H. G. Brackley. The trend of opinion among those who talked was that too little importance had been attached to the value of forecasts and too much to the assumption that frequent observations along a single route would be satisfactory. The distance of 30 to 50 miles from observing station to the route would be too great, but to put kite balloons closer would be dangerous for airplanes flying in that vicinity. Pilots want a concise statement before they start, and should be instructed to report conditions encountered in flight.—*C. L. M.*

BRITISH AND FRENCH RADIO WEATHER SERVICE FOR AVIATORS.

(Reprinted from *Science*, Sept. 17, 1920, p. 271.)

The Air Ministry, in an official notice to airmen, according to the London *Times*, details innovations recently introduced in the dissemination of meteorological statistics and forecasts by wireless telegraphy for the use of aircraft. Reports are issued from the Croydon aerodrome on a 900-meter continuous wave each day, including Sundays, at hourly intervals between 7:35 a. m. (G. M. T.) and 4:35 p. m., the data in each consisting of observations made 35 minutes previously at the following places: Felixstowe, Croydon, Biggin Hill, Lympne, Beachy Head, Dungeness, and Botley Hill (North Downs). In addition to the usual information, the messages now include the direction and speed of the low cloud, the character of the sea swell, and the visibility toward the sea is distinguished from that over the land, the latter important feature being observed at various points along the channel coast. A statement is also added regarding the conditions prevailing on the North Downs as viewed from Biggin Hill, while at 8:25 a. m.

[3] While no study of the accuracy of the *observed* pressures has been made, it has been estimated that it does not exceed 1 mb. The probable variation of the *computed* pressures, as determined by a statistical study of the data, is about 0.5 mb. for the 1-km. level, and 1.3 mb. for the 2-km. level, values which are in close agreement with the mean difference of the 20 random cases selected above. While 20 cases are too few to base generalizations upon, it would seem that the close agreement between the probable variation of a single value of computed pressure and the mean difference between observed and computed pressure would indicate that the probable error of a single observation of pressure is less than 1 mb., as estimated above. A study of a large number of computed and observed pressures might afford an indirect, but reliable, means of determining the probable error of pressure observations by the meteorograph.